Processing of Polymers and Polymer Composites
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Lecture – 40
Web based Tools for Polymer Matrix Composites

[FL] friends, welcome to the last lecturers for our course on Processing of Polymers and Polymer Composites**.** If I start with the review of the course I think the last session will go only in the review process only, but I will try to address an important issue related to the polymer matrix composites today. Just as is customary as we have been doing in our course I have been revising retreating or maybe kind of reviewing what we have been covering in the preview sessions. And today I will just have a brief review of the whole course that we have underground or that we have discussed. Today there is a lot of information available all across varies source is of information there are so many sources of information these days.

When we were students the only source of information was the books as well as the teacher these days number of other source is have been added in this information data base. You can get information from the internet, you can get information from the various CDs available, you can get information while discussing or the topic among the pear group. So, there are various sources of information these days that are available you can attend some seminars, you can attends some conferences, you can attend some workshops and get the information.

The major source of information today is the web we can login to internet we can just scan through the internet, we can look at the various websites and we will get lot of information. Similarly we have also tried in this course to get as much information as possible which is freely available and try to club this into one single source of information which is helpful to the student's community as well as the learners at large.

If you see in our course we have seen the processing of polymers and so many different process is we have covered for polymers starting from the smooth simplistic extrusion injunction molding, compression molding, casting, transfer molding, rotational molding blow molding and in each and every process we have taken help of the internet. We have taken various videos which are available on YouTube and tried them tried to use them in

order to explain the process. Similarly, in case of polymer matrix composites also we have try to understand the process is like the hand layup process the spray layup process compression molding, injunction molding, then resin transfer molding, filament winding pultrusion with the help of various videos that are available on internet

So, we have made use of internet in a big way and see and we have try to understand what is the information available and that information we have combined together in this course. Whatever we have covered in this course is not the only information that is available on internet. You can if you are interested you really want to understand the subject you can very easily see various other videos various other schematics various other diagrams various other figures various other explanations that are available on internet and I can assure you that you will get benefited your knowledge base will increase and you can even think of be covering an expert in this area of processing of polymers and polymer based composites why, because so much of information is available on the internet.

Today also why I am emphasizing the use of internet because today in our last session we are again going to see certain web based tools which are freely available which researcher or the research community has made freely available four people who are interested in the field of composite materials.

So, the title of today's course is the web base tools for polymer matrix composites and these tools are available and can be used by anybody. What is the use of these tools? Today we are going to see only two tools which are available on a website which is an important website for composite materials that is www dot net composites dot com. There are number of others such websites, but these two tools I could relate that are important for any composite engineer are any engineer who has information or basic information of composite materials. And these two tools will help practitioner to take informed decisions he can take a decision that whether this particular process or the particular material that he is going to develop is going to effect the environment or it is not going to effect the environment, if it is going to effect the environment what is the rating of that particular effect or impact.

So, this is not a very exhaustive tool, but is a very good tool for the understanding point of view even our learners can think of developing such type of tools where they can have

an analysis of the environmental impact of the composite material. Then the second tool that we are just going to have over view is that calculation of the properties of the composite material, as all of us know that polymer matrix composite materials usually have two major constituents that is the reinforcement and the matrix.

Now, reinforcement usually in terms of fibers they can be continents fibers or short fibers and the matrix can be a polymeric matrix which can be thermoset or a thermo plastic. So, based on the input properties of these two constituents the properties of the composite can be very easily calculated with a freely available web based tools that can easily be downloaded on your systems one can be used for free of cost.

So, today we will see two tools which have been developed by the that that composites dot com and launched on the website and can be lunched on your system if you have a internet connection and you can try to understand these tools and use them for your specific applications.

So, let us now, quickly understand the importance of these tools. First of all we acknowledge this source that is the tools are available at net composites dot com, a very good information or information data base for composite engineers. I regularly visit this website and look at the various enouncement the various developments in the field of composite materials. So, the website is you can see www dot net composites dot com.

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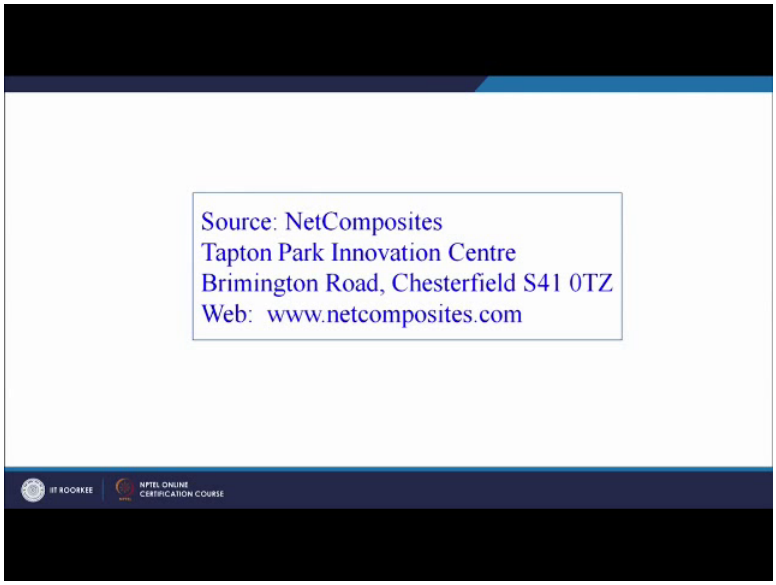

Now, the background of developing this tool is that products made from composite materials can offer significant environmental benefits because of their characteristically low weight good mechanical properties and excellent resistant to corrosion.

So, we have already seen the advantages of composite materials, but one important thing that is emphasized here is the environmental benefits. Now, why environmental benefits? Because of low weight because if we are using a composite material for aircraft or automobile application low weight will definitely improve the fuel efficiency of the aircraft as well as the auto mobile. And therefore, the environmental impact will be less because less fuel is brunt less emissions and the environmental sustainability can be ensured or environment friendliness can be ensured.

So, therefore, the composite materials definitely have an environmental impact as well as we can say with confidents of positive environmental impact because they reduce the weight of the com weight of the auto mobile or the aircraft in which they are being used.

However, the in service environmental benefits of composites are known there is far less understanding of the environmental and social implications associated with the manufacture of composite materials and products.

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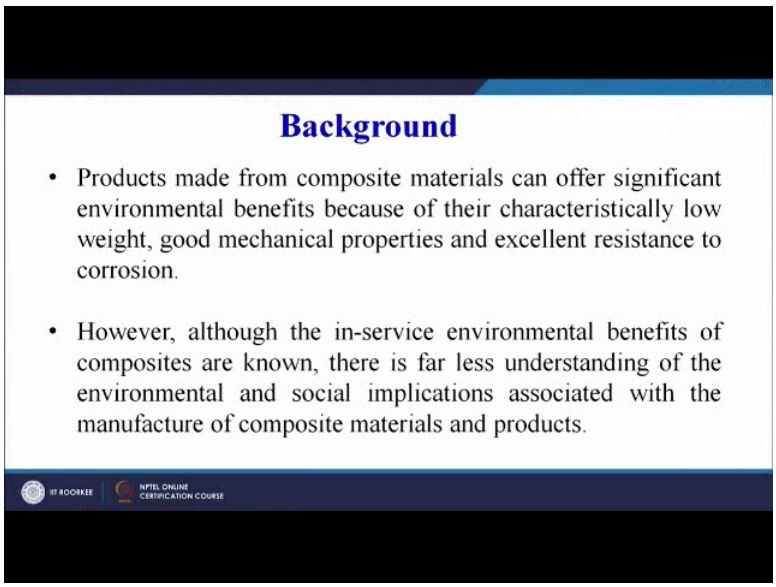

Now, from the application point of view we have seen that if you are using a composite part in an aircraft the weight of the aircraft we will reduce and will lead to significant

savings in fuel. Similarly 5 or 7 or 10 parts are used in a auto mobile or a car weight will be reduced and the fuel efficiency will improve that is from application point of view, but we need to understand that when we are processing a polymer matrix composite material what is the environmental impact. Many times the environmental impact may be much more severe than the savings that we are getting from the application point of view.

So, this tool which has been developed and which is available on net composites dot com is helping us to take a informed decision it is giving a rating to the process that what is the environmental impact whether the process is environment friendly or it is going to have an adverse effect on the environment. So, that is what we are going to see today. So, the guide which is available at net composites is created to enable the composite sector to understand the environmental and social impacts associated with the composites processing and assist with the decisions made about material and process choice.

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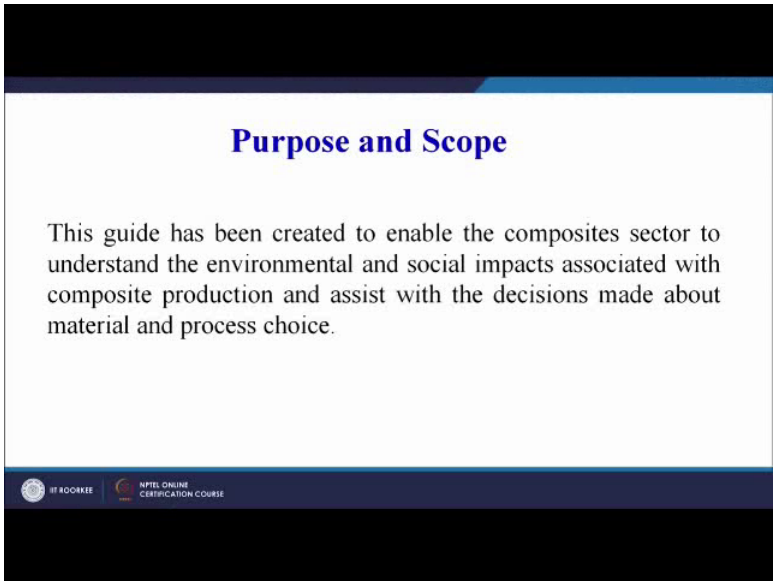

Now suppose you want to make a particular size of a product a particular shape of a product what you can input? You can input the material what is going to be the reinforcement what is going to be the matrix for example, glass fiber as the reinforcement and epoxies as the matrix material you can use hand layup process to make that composite part.

So, in hand layup whether your cleaning your mold with water or your cleaning your mold with acetone whether your using gloves for the process are not, if the gloves are

use what is the material of the gloves of that goes in to the micro detailing of the complete process and based on the input that you give to the system or the software or the tool it will make a prediction that what is the environmental impact of this process and then you can take a decision if the impact is adverse you can change your process in such a way that the environmental impact improves or impact there is no adverse environmental impact of the process. So, we can fine twin tweak our process makes certain decisions during our process that it does not have adverse impact on our environment. So, we will try to understand this with the help of an example.

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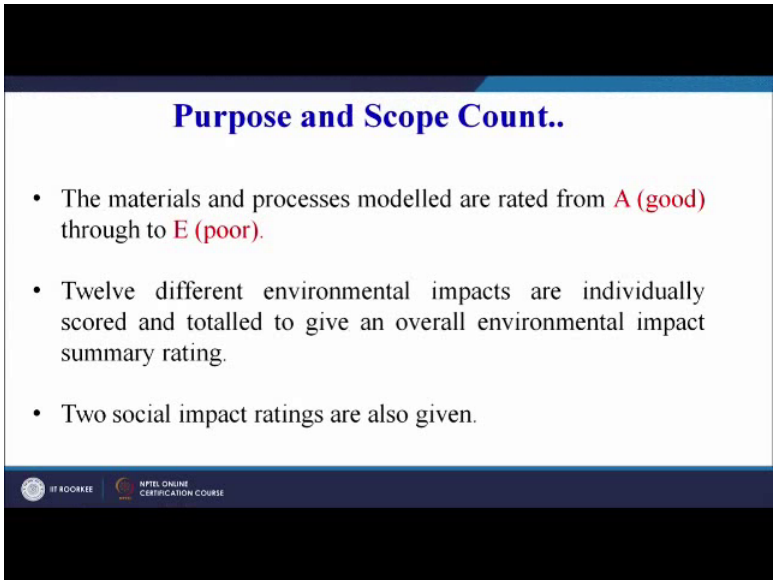

Now there is a scale that is from A to E. So, the materials and processes is modeled are rated from A through to E. So, A means if your rating is given A it means good, if the rating is E; that means, poor, so the materials and process are rated from A to E. Twelve different environmental impacts are individually scored and totaled to give an overall environmental impact summery rating. So, finally, for the process that we are using for making a composite part we will get a rating and that rating can be A, it can be E; A means that our product has been made using a environment friendly process. A rating of E means that the product has been manufactured by a process which is that detrimental to the environment and if it is that detrimental we can go back and we can choose the components, constituents process, process parameters accordingly, so that the environment friendly process can be developed. So, the two social impact ratings are also given in the summary or the output.

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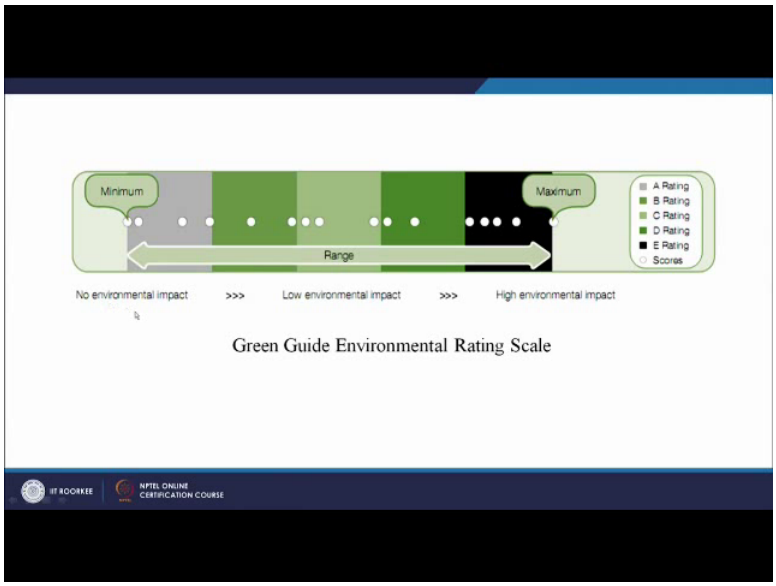

Here we can see this is a green guide environmental rating scale. So, this is the minimum no environmental impact and this is the high environmental impact. So, the gray color is a rating and dark black color is E rating. So, these are the scores gray is this side. So, minimum environmental impact or no environmental impact and this is maximum black color that is the E rating that is the high environmental impact.

Now, how you can use this tool? The green guide tool was by using a dynamic quotient process which calculates of final green guide rating based upon the answers provided. Now, we have to input as in our last session we have seen that we have also that IIT, Roorkee develop the tool which can give the prediction of the forces and the damage in case of drilling of polymer matrix composites. So, similarly in this tool also we have to input a material the process the details related to the process and then the software will help us to see whether our process is environment friendly or it is detrimental to the environment.

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This is the link given that how you can launch this tool we have to first visit the website that is www dot net composites dot com. Then guides and tools is one link from there we have to go to tools then we have to go to green guide read more and then we have to launch tool and after launch tool we can use the tool there is lot of information available and then we can very easily use this tool by get clicking on the various links.

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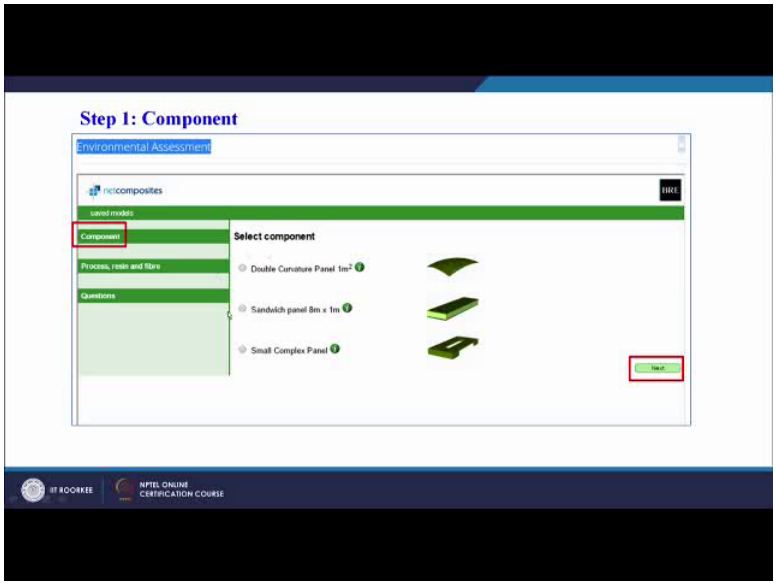

Now this is going to be our first step while we use this tool we have to select the component. Now, three components are pre entered into the system. So, we have to

choose among these three component one is a double curvature panel of one meter square surface area sandwich panel 8 meter into 1 meter and small complex this is geometry for the complex panel. So, first we have to select we have to mark the bubble or click on a bubble and select the shape that we want to analyze.

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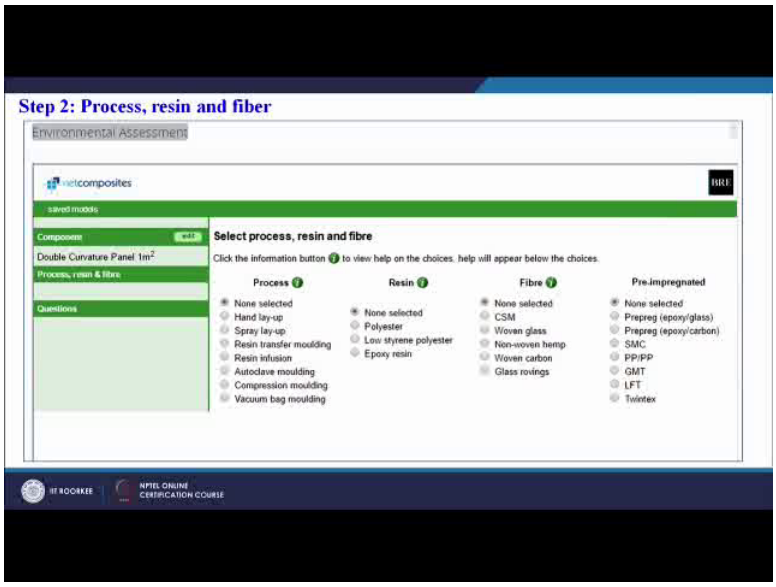

Then in next we have to suppose we have selected the double curvature panel one meter square surface area. So, the shape of the product is already selected then we have to select the process the resin and the fibre the resin can be the matrix solve the polymer and we have to select the fibre.

Now, we have to see what are the process is that can be selected here we can see all the processes, by now I think you know the process can be hand layup process spray layup process resin transfer molding, resin infusion, autoclave moulding, compression moulding, vacuum bag moulding. All this process details all of you know by now. So, we have to select that this double curvature panel of one meter square can be made by what processor or which process then we have to select the resin three are three choices are there polyester low styrene polyester and epoxy resin. Then the fibre we can select whether it is woven glass or nonwoven hamper woven carbon or glass rovings, then we have to see pre impregnated whether if it is a prepreg then we have to select suppose we are using a prepreg which is of glass epoxy then we can click here that in our case the row material is a prepreg which has glass and epoxy glass as the reinforcement and

epoxy as the matrix or we can if carbon and epoxy as the prepreg material also. So, there you can see there are lot of choices which are available with the user and we can select these choices as a input to our system or input to the tool.

So, here process resin and fiber we can select. So, we have seen here that we can see here that hand layup process is selected the bubble has been highlighted.

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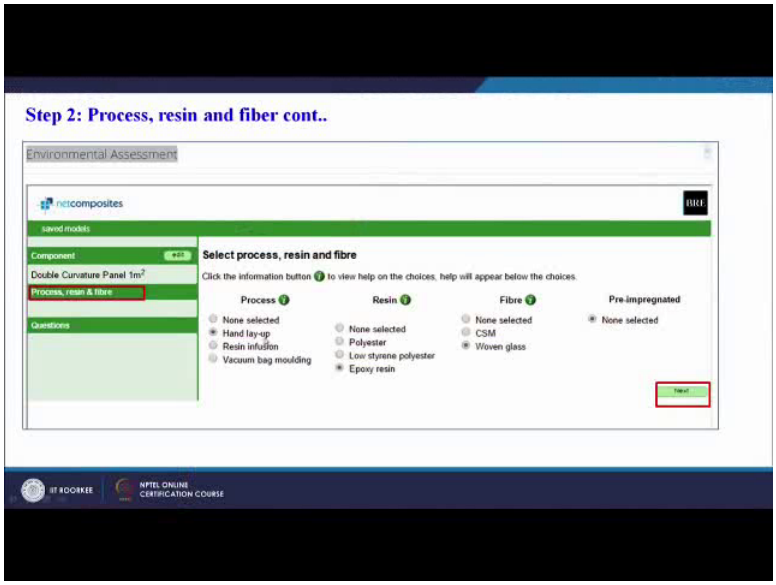

We have selected epoxy resin and we have selected woven glass fibre, pre impregnated we have we are telling that it is a hand layup process we are not using the prepregs, so pre impregnated fibres are not used. So, directly most simplest case we have taken that the glass fiber epoxy composite laminate is being made using the hand layup process.

Then we go to next stage there are so many questions here.

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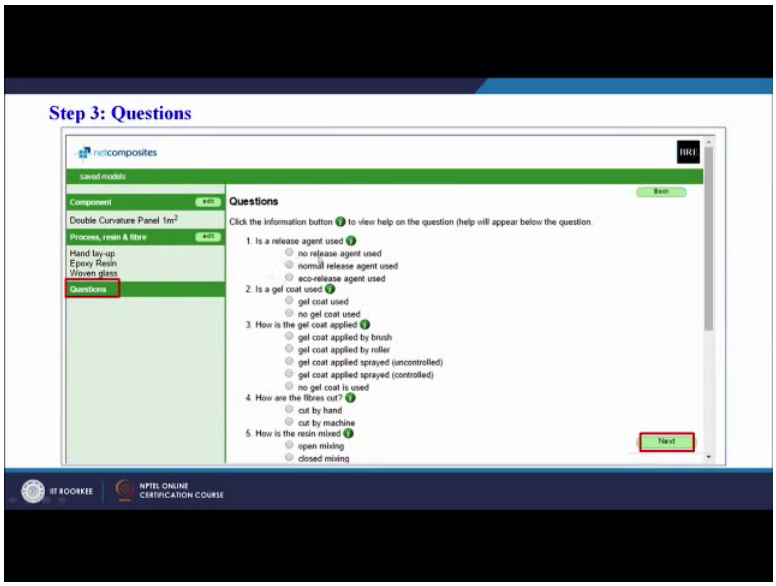

In the questions we have is a release agent used. Now, all of you must be remembering or maybe knowing that in case of hand layup process or in any closed mould manufacturing process or whether it is open mould or closed mould we have to spray a release gel or apply release agents. So, that the composite are the laminate do not stick to the mould.

So, that there are general questions like is a release agent used is the gel coat used, how is the gel coat applied gel coat applied by brush, gel coat applied by roller, gel coat applied or it is sprayed gel coat applied sprayed controlled manner or uncontrolled manner how are the fibres cut. They are cut by hand their cut by machine how is the resin mixed open mixing closed mixing. So, you can see there are so many questions related to the process that affect the environment. Why these questions are important? These questions are important because they affect the environment. We have to answer these questions then only our tool will be able to access our process based on the environmental impact.

So, we have to answer all these questions. So, what we have done till now, we have selected a process that is hand layup, we have selected the fibre that is woven glass fibre, we have selected the resin or the matrix that is epoxy in our case we are not using any prepregs. General questions related to the process also we have added such as the fibres where cut by hand or by machine or how the resin was mixed whether the gel coat was applied or not applied. So, all these questions we have answered.

Now, the tool has got plenty of information to make a decision that what is the impact of our process on the environment.

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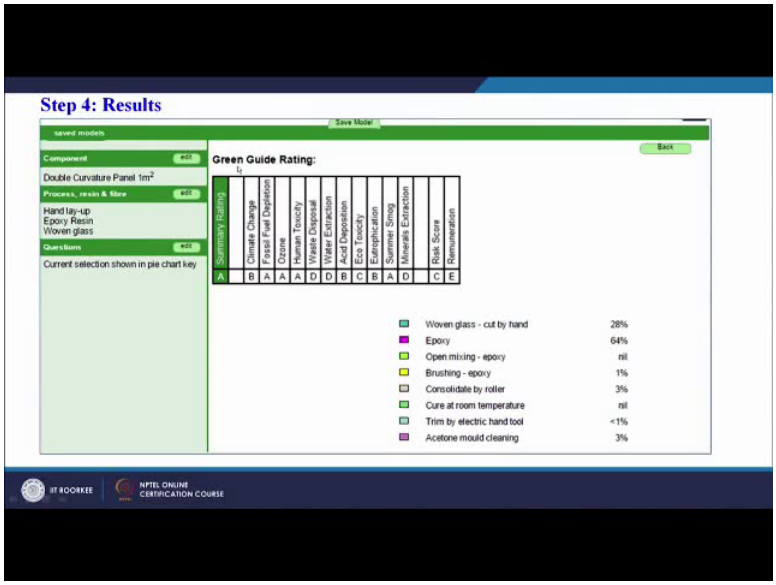

And this is the result we can see green guide rating this type of rating will be generated and here we can see B A A A D D B. So, our rating will very from A to E, A means good E means poor. So, A in this case we get ozone. So, our process maybe is not having any effect on the ozone layer depletion. So, we get a good rating on this there can be other process in which there can be effect on the ozone layer and therefore, we will get a poor rating for that.

Similarly this waste disposal point of view you can see our process is getting de-rated our process as well as our material is getting de-rated. Why this is getting de-rated because we are used glass fibre which is non degradable, we are using epoxy which is non degradable. So, therefore, the from materials point of view our process get de-rated.

So, we can see that even the percentage is also given woven glass cut by hand 28 percent effect on the this is kind of social impact also because a glass fibres are carcinogenic in nature, glass fibres are hazardous they are abrasive in nature. So, we will get different types of rating ranging from A to E and this will help us to take a informed decision that whether our process is environment friendly or it is detrimental to the environment.

So, because of the paucity of time we may not be able to see each one of this I request I urge all of you to visit the website and launch the tool and see that what are the possible decisions that can be made based on this green guide that is available on net composites.

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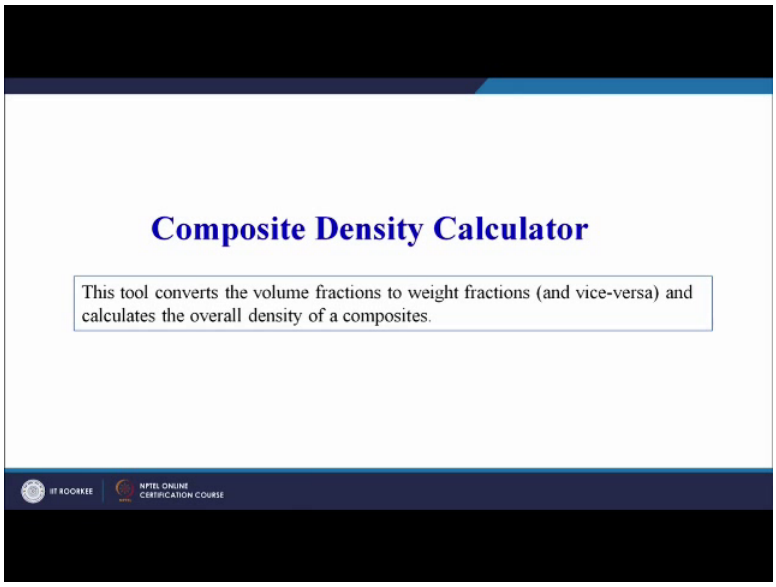

Then in the same website there is a composite density calculator. So, this tool converts the volume fractions to weight fractions and vice versa and calculates the overall density of the composites. Here also we have to input the information inform of the fibre the resin and finally, the system will calculate the density of the composite develop based on the fibre and the resin.

Let us see very quickly again we have to go to the website guides and tools, in tools we have to go to the calculators.

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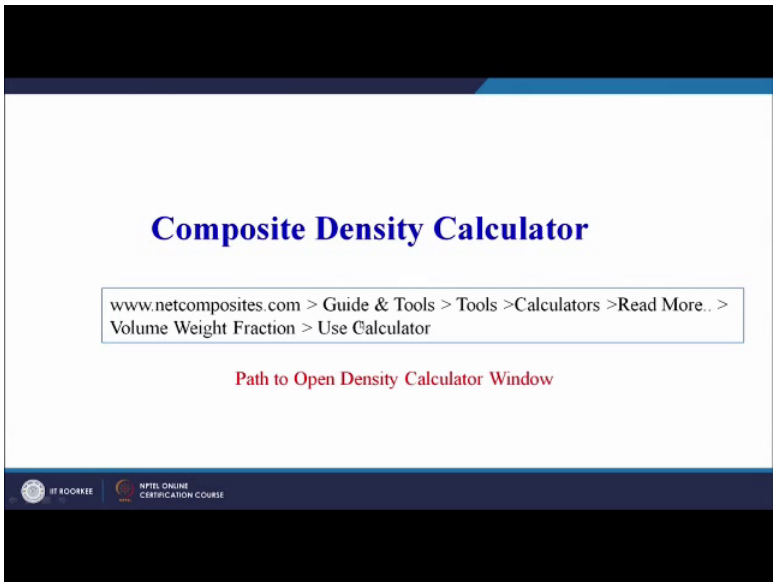

And then we have to go for volume weight fraction calculator then we can use the calculator.

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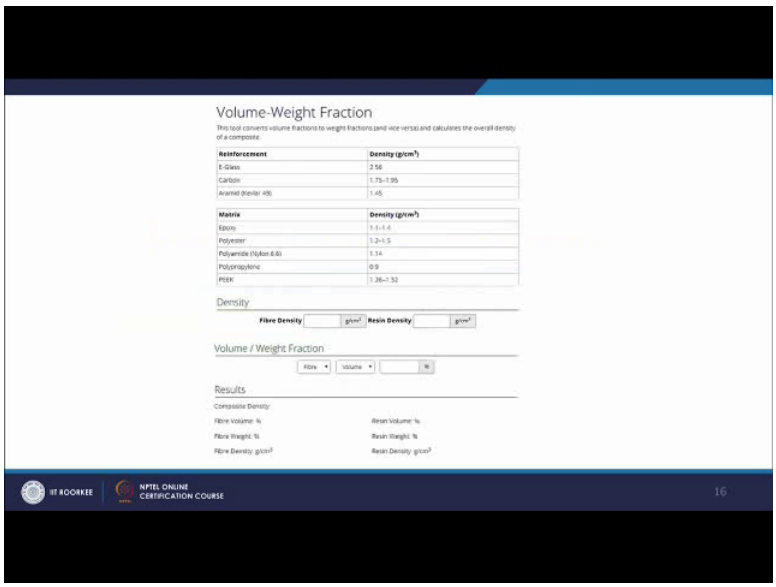

When we use the calculator we will get this type of a display in which the reinforcement and the density is preloaded. Now, for E glass the density is given, carbon the density is given, aramid the density is given, similarly for matrix also epoxy, polyester, polyamide, polypropylene, poly (Refer Time: 23:15) the density values or the range of density values are given.

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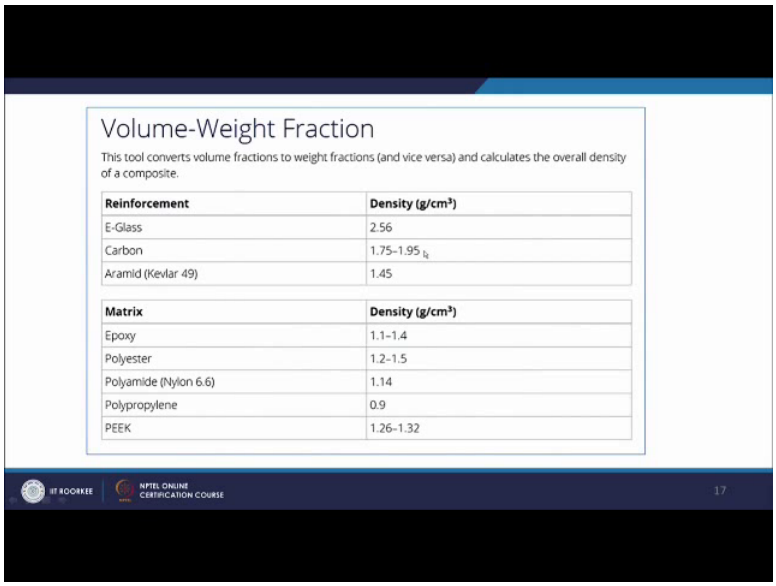

So, you can see here volume weight fraction this is the information that is already available and once we select that this is going to be we our reinforcement suppose we take carbon as our reinforcement and epoxy as our matrix. So, we have to give the values accordingly the density of the carbon we have to input the density of the polyester or the epoxy whatever we select we have to input and then this tool will calculate the density of the composite.

One more information we have to provide that how much fibres are present in our com composite and how much matrix is present in our composite. So, we can specify the volume fraction or we can specify the weight fraction. So, once we specify this three input properties that is we input density the of the fiber we input the density of the matrix and we input the volume or the weight fraction of the metrics or the reinforcement the system will do the calculation and will give us that composite density or the density of the composite.

Let us try to see an example.

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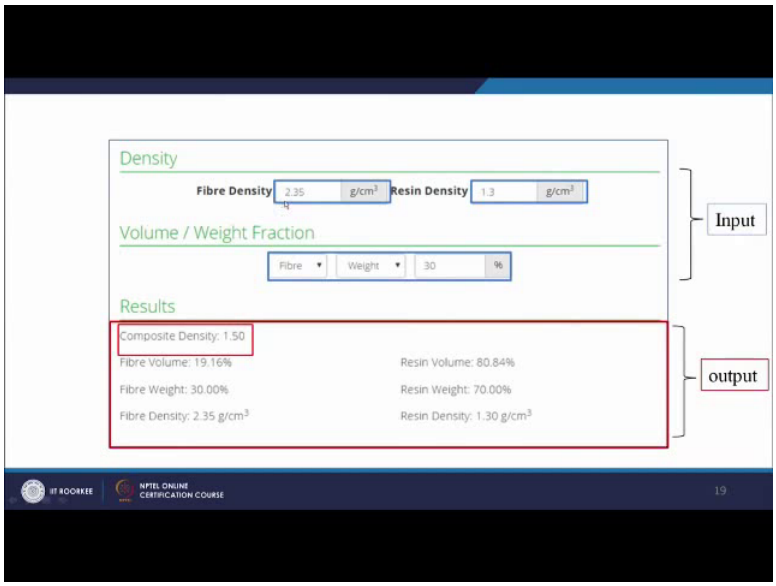

We have to input the density fibre density information or data is already given on the very front page or first page of the calculator we have to give the resin density in gram per centimeter cube then volume or weight fraction we have to give. Once we specify this we will get the results in terms of suppose we have given the volume fraction we will get the resin weight fraction, we will get the fibre weight fraction, we will get the composite density as well.

Now, this is one example, you can see the fibre density selected is 2.35 gram per centimeter cube, the resin density selected is 1.3 gram per centimeter cube, the fibre weight fraction is 30 percent and the results are the composite density is 1.50. The fibre volume fraction is given resin volume fraction is given, fibre weight fraction is given, resin weight fraction, fibre weight fraction already 30 percent we have given as input, so resin weight fraction automatically comes out to be 70 percent fibre density and resin density already we have selected. So, based on these type of tools we can very easily do calculations regarding the composite density.

And here we can see these are the inputs. So, the input is the fibre density the matrix are the resin density and the volume or the weight fraction of the fibre or the matrix and output is the composite density.

So, number of such calculators tools are available freely on the web or the internet it is for us to look up for such type of information such related important and we can say

useful tools which can help us in order to improve our understanding of the concept of polymers as well as polymer composites. Also such tools are helpful to us in application point of view in various applications where we want to use a composite material. As all of us are from the academic background such tools are also helpful for the academic students or for the academicians where they can you such tools for completing their thesis work project work dissertation work.

So, with this we come to the end of our course on processing of polymers and polymer composites. I hope that you may have enjoyed the course in case you have any query any doubt you can write to me we would be more than happy to answer your queries to the best of our abilities. And I believe that with little information that we have covered because in composites lot of other information is available this is a very big research area very big we can say umbrella under which different types of topics can be covered, but we have try to focus our attention on the manufacturing aspects, on the processing aspects of polymers and polymer composites.

And why it is important because government of India has initiated a make in India campaign and with foreign companies multinational companies visiting India setting up their manufacturing facilities in India may lead to the use of composite materials for various products. And once we have basic understanding of the processing techniques and tools for composite materials even our employment prospects improve. So, I wish all the learners, all the students you are registered for this course a very bright future and I wish best of luck to all of you.

Thank you.